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Formulation and Physicochemical Properties Evaluation of an Innovative *Halalan Toyyiban* Healthy Bar to Boost Cognitive Performance

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ABSTRACT

Nowadays, incorporating healthy snacking into the diet is becoming popular since consumers have become more health conscious. With a broad range of snacks, snack bars have climbed the chart of preferred snacks, especially among children and adolescents. Given this known fact, this study aims to formulate healthy bars and determine their physical and chemical properties in light to improve cognitive performance. The formulation of the healthy bars was developed using design expert software. After that, the healthy bars were applied to proximate, fatty acid profiling, vitamin, mineral and antioxidant analyses, and their texture and colour properties were evaluated. The study found high nutritional value and excellent physical characteristics for healthy bars. More specifically, they have low moisture content, high in protein, essential fat (omega-3 and omega-6), fibre, vitamins and mineral, with outstanding antioxidant activity and a remarkable texture and colour as reported in previous studies. Overall, with the high essential fat, vitamin and mineral contents, and high antioxidant activity compared to recommended nutrient intake (RNI) for Malaysian children and adolescents, this healthy bar can help to improve their cognitive performance.

Keywords: Healthy snacking; Healthy bar; Physical properties; Chemical properties; Antioxidant activity; Essential fat; RNI

1 Introduction

The current trend shows that consumers have been slowly shifting their eating and snacking habits to a smarter and healthier way. Consumers are free to choose a broad range of snacks to indulge their perception of healthy snacking. One of the preferable snacks in the market is snack bars [1] which recently dominated the breakfast aisle in grocery stores [2]. Addressing the urgent need of 'healthy bars', the manufacturers have started to enrich their snack bars with nutrients such as vitamins, minerals, antioxidant and fibre [3,4]. With the latest



innovation, this healthy bar can attract a broader range of consumers especially youngsters, the most significant contributor to snack bars purchasing globally [5]. Thus, the objectives of the recent study were to develop a healthy bar formulation that can help improve brain function especially among children and adolescents and to determine their physicochemical properties. Therefore, proximate, vitamin and mineral analyses were conducted along with an antioxidant activity to determine its nutritional value while evaluating its texture and colour properties.

2 Materials and Methods

2.1 Materials

The formulation of healthy bar consisted of several parts including the functional ingredients, such as date powder, *Moringa oleifera* powder and Sacha inchi oil, were purchased from local manufacturers around Selangor. Meanwhile, the body of the healthy bar, which included bubble rice, pumpkin seeds and oats, was also purchased from a local manufacturer in Klang, Selangor, and Beryl's dark chocolate compound was used as the coating for this healthy bar.

2.2 Methods

2.2.1 Formulation of Healthy Bar

The functional ingredients (Sacha inchi oil, date powder and *Moringa oleifera* powder) were optimised according to the simplex lattice design [6] with a maximum of 25% of the total 25.00 g healthy bar recipe. The other ingredients used were dark chocolate compound, bubble rice, oats and pumpkin seeds, being kept constant throughout the study. A previous study recorded that the upper limit of Sacha inchi oil, date powder and *Moringa oleifera* powder was 10.0%, 12.5% and 7.5%, respectively. Meanwhile, the lower limit of these ingredients was 5.0%, 7.5% and 2.5%, respectively [7]. These limits were submitted in the Stat Ease Design Expert Version 12, resulting in the 14 formulas of healthy bar.

2.2.2 Proximate Analysis

Proximate composition of the 14 healthy bars consisted of moisture, ash, protein, fat, fibre, carbohydrate, and energy content which were determined according to the AOAC method 18th ed. 2005, 984.25, 923.03, 981.10, 991.36, 962.09 respectively. The measurement was done in triplicate.

2.2.3 Fatty Acid Profiling

Referring to the result of proximate analysis, only two healthy bar formulations were selected to be further analysed. The fatty acid profiling was also conducted according to the AOAC method 20th ed. 2016, 996.06. The measurement was carried out in triplicate.

2.2.4 Mineral, Vitamin and Antioxidant Analyses

The mineral content (magnesium) of the selected healthy bar formulations was determined using atomic absorption spectroscopy (AAS) Method No: STP/Chem/A13-AAS. Meanwhile,

vitamin E (α -tocopherol) content was determined using high performance liquid chromatography (HPLC) Method No: STP/Chem/A11-HPLC and antioxidant activity were evaluated by monitoring DPPH inhibition (%). The measurement was done in triplicate.

2.2.5 Texture and Colour Evaluation

Two of the selected healthy bar formulations were tested for hardness using Texture Analyzer TA-XT Plus (Stable Micro System, London), referring to the method as previously described [8]. To evaluate the colour of the selected healthy bar, Hunter Lab Colorimeter (LabScan XE Spectrophotometer, Hong Kong) was used as described in the previous study [9]. The measurement was carried out in triplicate.

2.2.6 Statistical Analysis

All statistical analyses were performed using SPSS (20.0, IBM) software. Data were analysed using analysis of variance (ANOVA), which allows for testing relationships between variables. All measurements were repeated 3 times, and differences between the mean values of samples were checked for significance (* $p < 0.05$).

3 Results

3.1 Proximate Content of Healthy Bar

Proximate analysis was conducted to determine the nutrient content of food products. The nutrient content of the 14 healthy bars is in Table 1 below.

Table 1: Proximate content of the healthy bar

Formulation	Test Parameter / Nutrition facts (per 100 g)						
	Protein	Moisture	Ash	Fat	Crude fibre	Carbohydrate	Energy
1	9.38 g \pm 0.45 ^c	6.09 g \pm 0.09 ^b	2.76 g \pm 0.03 ^b	17.80 g \pm 0.22 ^c	2.30 g \pm 0.29 ^b	63.97 ^a g	453.61 ^b kcal
2	9.67 g \pm 0.43 ^c	7.10 g \pm 0.27 ^a	2.49 g \pm 0.03 ^b	18.17 g \pm 0.73 ^c	3.47 g \pm 0.24 ^a	62.56 ^a g	452.45 ^b kcal
3	9.80 g \pm 0.09 ^c	7.69 g \pm 0.08 ^a	2.37 g \pm 0.03 ^b	19.68 g \pm 0.29 ^b	2.34 g \pm 0.09 ^b	60.48 ^a g	458.21 ^b kcal
4	9.51 g \pm 0.13 ^c	7.87 g \pm 1.51 ^a	2.43 g \pm 0.02 ^b	19.59 g \pm 0.49 ^b	2.75 g \pm 0.04 ^b	60.60 ^a g	456.73 ^b kcal
5	9.41 g \pm 0.06 ^c	6.80 g \pm 0.16 ^b	2.49 g \pm 0.06 ^b	16.83 g \pm 0.16 ^c	1.67 g \pm 0.35 ^c	64.47 ^a g	446.98 ^b kcal
6	9.82 g \pm 0.51 ^c	6.41 g \pm 0.11 ^b	2.85 g \pm 0.07 ^b	15.06 g \pm 0.23 ^c	2.55 g \pm 0.25 ^b	65.87 ^a g	438.25 ^b kcal
7	10.03 g \pm 0.11 ^c	6.02 g \pm 0.07 ^b	2.57 g \pm 0.01 ^b	17.86 g \pm 0.31 ^c	1.49 g \pm 0.29 ^c	63.52 ^a g	454.92 ^b kcal
8	9.43 g \pm 0.06 ^c	5.97 g \pm 0.51 ^c	2.44 g \pm 0.05 ^b	18.73 g \pm 0.90 ^c	1.38 g \pm 0.11 ^c	63.43 ^a g	460.01 ^b kcal
9	9.33 g \pm 0.08 ^c	5.23 g \pm 0.15 ^c	2.36 g \pm 0.06 ^b	21.01 g \pm 0.95 ^b	2.17 g \pm 0.32 ^b	62.07 ^a g	474.67 ^b kcal
10	10.38 g \pm 0.18 ^b	5.15 g \pm 0.12 ^c	2.35 g \pm 0.011 ^b	20.22 g \pm 0.27 ^b	2.14 g \pm 0.19 ^b	61.90 ^a g	471.10 ^b kcal
11	10.31 g \pm 0.08 ^b	5.25 g \pm 0.12 ^c	2.31 g \pm 0.007 ^b	22.76 g \pm 0.13 ^b	1.92 g \pm 0.04 ^c	59.37 ^a g	483.58 ^b kcal
12	10.86 g \pm 0.16 ^a	5.81 g \pm 0.09 ^c	2.33 g \pm 0.009 ^b	19.88 g \pm 0.64 ^b	3.36 g \pm 0.22 ^a	61.12 ^a g	486.83 ^b kcal
13	10.96 g \pm 0.04 ^a	5.43 g \pm 0.35 ^c	2.17 g \pm 0.006 ^b	20.91 g \pm 0.56 ^b	2.42 g \pm 0.43 ^b	60.53 ^a g	474.13 ^b kcal
14	10.51 g \pm 0.09 ^a	5.62 g \pm 0.03 ^c	2.29 g \pm 0.005 ^b	21.31 g \pm 0.43 ^b	3.34 g \pm 0.23 ^a	60.28 ^a g	474.92 ^b kcal

Values are means \pm SD. Values with the same letters within the same column are not significantly different ($p < 0.05$).

3.2 Fatty Acid Profiling of Healthy Bar

Based on the proximate result in Table 1, Formulation 12 and Formulation 14 exhibited the most excellent nutrient content of the healthy bar. The fatty acid profile for both formulations is displayed in Table 2 below.

Table 2: Fatty acid profile of the healthy bar

Formulation	Fatty acid profile (mg /100 g sample)	
	Linoleic (cis)	α -Linolenic
12	5742.31 ^a	1283.18 ^a
14	6797.84 ^a	3011.79 ^a

3.3 Mineral, Vitamin and Antioxidant Content of Healthy Bar

The mineral, vitamin and antioxidant content of the selected healthy bars are shown in Table 3 below.

Table 3: Mineral, vitamin and antioxidant content of the healthy bar

Formulation	Analysis		
	Magnesium (mg/kg)	Vitamin E as α -tocopherol (mg/100g)	DPPH (% inhibition)
12	1166 ^a	0.43 ^a	7.37 ^a
14	1152 ^a	0.80 ^a	8.91 ^a

3.4 Texture and Colour Evaluation of Healthy Bar

The texture of the healthy bars (Formulation 12 and Formulation 14) recorded a hardness (N) of 24.03 ± 2.49 and 23.59 ± 2.67 respectively. Meanwhile, colour properties of the selected healthy bars were L^* 48.97 ± 0.84 and 44.02 ± 0.14 , a^* 4.79 ± 0.11 and 6.62 ± 0.14 , and b^* 20.82 ± 0.60 and 24.70 ± 0.40 accordingly.

4 Discussion

The proximate, essential fatty acid, mineral, and vitamin content results were compared to the recommended nutrient intake (RNI) [10] for Malaysian children and adolescents. The results indicated that the healthy bar complied with the RNI and could improve children's and adolescents' cognitive performance. Meanwhile, the antioxidant activity, textural and colour properties of the healthy bar were significant, as mentioned in a previous study [3].

5 Conclusions

The formulated healthy bar could impart a positive effect on improving cognitive performance among children and adolescents. Based on its excellent nutritional value, high essential fatty acid, a substantial amount of magnesium and vitamin E (α -tocopherol) and significant antioxidant activity, this healthy bar should be seen as one that plays a vital role in boosting brain function whilst coping with the daily RNI. This healthy bar could be an eye-opener to the snack bar market that only focuses on providing energy.

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